Fish Passage Inventory and Barrier Assessment on U.S. Fish and Wildlife Service Lands: Watershed Resource Inventory Areas 1-23

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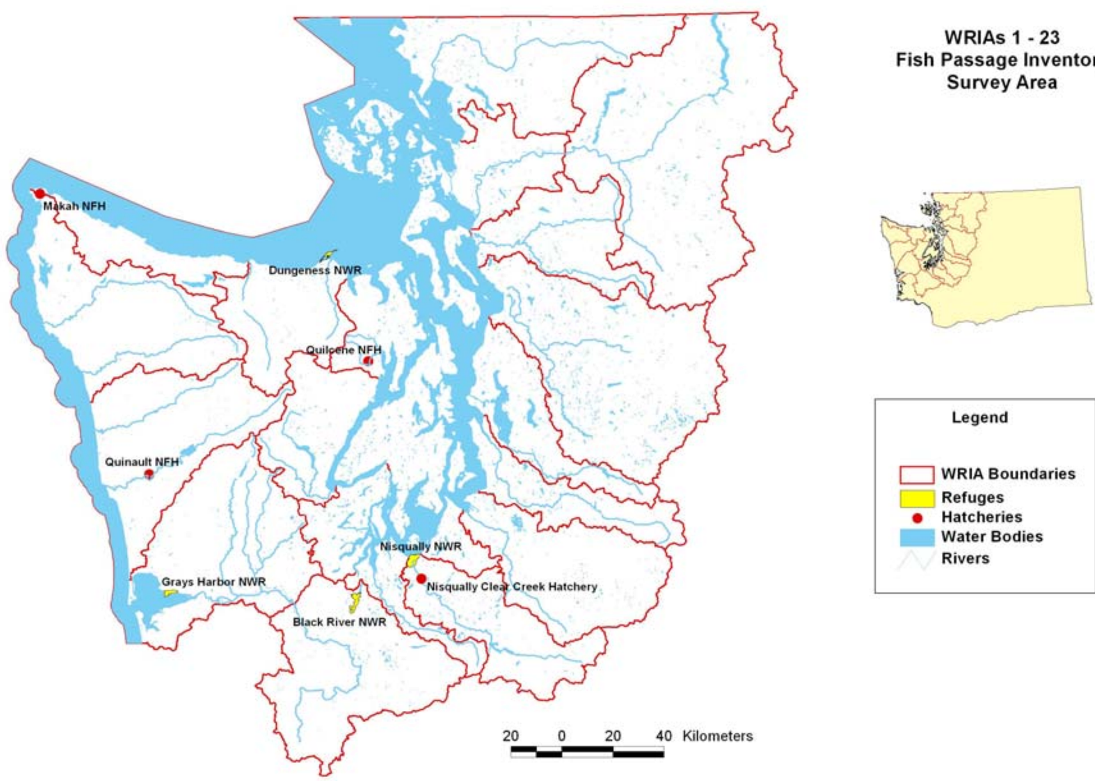
Introduction

As a result of the 1974 *United States* versus *Washington* (*U.S.* v. *WA*) case (*Boldt* decision), Western Washington Treaty Tribes became co-managers of fisheries in Washington State along with the Washington Department of Fish and Wildlife (WDFW), and the Tribes earned the rights to half of all harvestable fish in their usual and accustomed grounds and stations. The current *U.S.* v. *WA* sub-proceeding (*Boldt* culvert case) specifically addresses the impacts of barrier and partial barrier culverts on anadromous fish passage, and how these barriers may affect the number of salmon available with regard to Tribal Treaty fishing rights. Through participation in the settlement negotiations of the *Boldt* culvert case, the U.S. Fish and Wildlife Service (Service) recognized the need to document and prioritize all fish passage barriers on Service lands within the case area, specifically Watershed Resource Inventory Areas (WRIA) 1-23 (Figure 1).

Figure 1. WRIA 1-23 Refuge and Hatchery Facilities



The Western Washington Fish and Wildlife Office Fisheries Division received funds in fiscal year 2003 through the National Fish Passage Program. These funds were used to conduct a complete barrier assessment of Service lands in WRIA's 1-23 during August and September of 2003. In addition to culverts at road-stream crossings, all other structures that potentially impact fish passage were assessed. The survey included hatchery facilities and National Wildlife Refuges (NWR) owned and managed by the

Service, specifically: the Makah, Quilcene, and Quinault National Fish Hatcheries (NFH); and the Nisqually (including the Black River and Grays Harbor units) and Dungeness NWR. We also surveyed the Nisqually Fish Hatchery at Clear Creek (FHCC), which is Service owned, but operated by the Nisqually Tribe under an agreement with the Service (Figure 1). In addition, the NWR system has conservation easements on nine properties throughout WRIA's 1-23. At this time it is unclear if the Service is responsible for providing fish passage on these properties. Therefore, these nine properties were not included in the fish passage assessment.

Documentation of barriers to fish passage and prioritization for replacement is a significant first step towards increasing habitat for anadromous and resident salmonids, as well as other native fish species and aquatic organisms. Future barrier replacement efforts may eventually focus on the full ecological function of streams, such as how these structures impact the movement of invertebrates, sediment, and wood, as well as the physical and biological function of streams.

Survey Methodology and Materials

Environmental compliance for the fish barrier assessment was completed before field work began. Endangered Species Act compliance was completed on July 23, 2003. The assessment was covered by the Programmatic Biological Assessment for Habitat Restoration Activities (USFWS 2002), restoration activity number 13 (collect information/monitor). Anticipated impacts from this assessment included the following: temporary disturbance and displacement of fish and wildlife species; and, temporary disruption of onsite vegetation. In order to minimize these impacts, all applicable best management practices were implemented, including number 31 which states: "Stream surveyors will stay out of the channel as much as possible. If and when surveyors enter the channel, they will avoid disturbing spawning areas."

Additionally, National Environmental Protection Act compliance was completed on July 25, 2003. This assessment met categorical exclusion B.(1) which states: "Research, inventory, and information collection activities directly related to the conservation of fish and wildlife resources which involve negligible animal mortality or habitat destruction, no introduction of contaminants, or no introduction of organisms not indigenous to the affected ecosystem."

Initial contact with the refuge and hatchery facility managers was made via phone to determine the possible presence of fish barriers within these properties. Site visits were conducted at each facility after permission was obtained to survey the refuge and hatchery facilities. Several of the refuge properties are wildlife sanctuaries on rock islands with no man-made structures and/or waterways, so a site visit was deemed unnecessary. ArcView GIS generated maps were utilized while in the field to determine the location of potential fish barriers. The GIS maps included the following layers: hydrology, roads, Service ownership, Washington Department of Natural Resources (WDNR) stream typing, and township, range, section locations.

Surveys were completed according to the protocols set forth in the WDFW "Fish Passage Barrier Assessment and Prioritization Manual" of the Technical Applications Division (TAPPS 2000). We utilized this protocol because it is widely accepted throughout Washington and many local, state, and federal agencies and other groups have or are currently utilizing it. The protocol provides a standard method of data collection across the state, a means to prioritize fish barriers for replacement across differing jurisdictions, and a single database depository. The protocol is also an accepted method for assessing barriers for the *Boldt* culvert case.

The first step at each site was to identify each feature as a culvert, fishway, dam, gravity diversion, pump diversion, or other. When applicable, additional information was obtained for each feature, which included the following:

<u>Fish bearing waters</u> The first step at each site was to identify whether the waterway was fish bearing. To make this determination, waterways were evaluated to determine if they:

(1) were WDNR mapped type 1-4 waterways;
(2) had documented presence of salmonids through visual observation, electrofishing, or verification by local biologists;
(3) were water courses having ordinary high water widths greater than 0.60 meters (m) and gradients less than 20%; or,
(4) were listed in "A Catalog of Washington Streams and Salmon Utilization" (Phinney and Bucknell 1975).

In most cases, the refuge and hatchery managers also had documentation of current and historical fish utilization for the waterways surveyed. If none of these criteria were met, the waterway was assessed as non-fish bearing. If any of these criteria were met but fish presence was questionable, then the waterway was evaluated as unknown for fish presence. Using the WDFW criteria, fish presence at each site was evaluated as *potential* presence, if the habitat above were made accessible. The barrier assessment was not necessarily intended to identify whether or not fish are currently using the habitat.

<u>Fish passage determination</u> Within the TAPPS manual protocol, there are three categories for fish passability: passable, impassable, or unknown. The protocol has been designed to assess fish passability for all juvenile through adult salmonid life stages. Partial barriers were rated as a percentile of the degree of passability (0%, 33%, 67%, 100%); impassable status does not always indicate a barrier to all fish species or life stages.

A Level A analysis was completed for initial barrier determination of culverts, and if barrier status could not be determined at this level, a Level B analysis was initiated (see Appendix B for Level A and B analysis flow charts). Based on the Level B analysis, the barrier status of a culvert was unknown if there was a grade break within the culvert, a downstream control point was inaccessible, or the culvert was submerged. The downstream control was typically the head of the first riffle downstream of the culvert, where measurements must be taken for the Level B analysis. If the culvert was tidally influenced, or there was a wetland or large pond downstream of the culvert, then the downstream control was inaccessible.

In accordance with the TAPPS manual protocol, pump and gravity water diversions were evaluated on the basis of fish protection, not fish passage, and therefore were recorded as no-status for the barrier assessment. If a dam was associated with a water diversion, then the facility was evaluated for fish passage at the dam. Fish passage at dams was evaluated based on the following criteria: In streams where chum salmon were present, and the water level difference up and down stream of the dam was greater than 0.24 m, then the dam was identified as a barrier. If the stream was not used by chum salmon, and the water level difference up and down stream of the dam was greater than 0.30 m, then the dam was a barrier.

A laser mounted on a monopod was used to obtain the culvert length and slope, and a metric stadia rod was used for all other measurements. Photographs were taken with a digital camera, and site location was recorded using a GPS receiver.

<u>Stream simulation determination</u> A discrepancy exists between the TAPPS manual protocol determination of a fish barrier and the WDFW stream simulation design for installing fish passable culverts. In order to address this discrepancy (explained in the next paragraph) and in addition to the measurements taken following the TAPPS manual protocol, measurements were also taken for the WDFW stream simulation model on culverts that satisfied certain requirements (see Appendix B for stream simulation model flow chart). The stream simulation model is “a design method used to create or maintain natural stream processes in a culvert. Stream simulation is based on the principle that, if fish can migrate through the natural channel, they can also migrate through a man-made channel that simulates the stream channel” (Bates et al. 2003).

According to the TAPPS manual protocol, a culvert is considered passable if it has streambed material throughout, and the ratio of the diameter of the culvert to the toe width of the stream is 75% or greater. However, a culvert that is determined passable by the TAPPS manual protocol may not meet the specifications required of the WDFW stream simulation design criteria. To determine whether an existing culvert meets the stream simulation criteria, the bankfull channel width and the slope of the streambed are measured in comparison with the existing culvert diameter and slope. The culvert bed diameter should be 1.2 times the bankfull channel width, plus 2 feet; and the slope ratio of the stream to the culvert should be no greater than 1.25 (see Appendix B for stream simulation model flow chart).

<u>Habitat assessment</u> For each culvert that is determined to be a fish passage barrier, it is necessary to perform a physical habitat assessment to prioritize the barrier for correction. The physical habitat assessment quantifies the amount of spawning and rearing habitat available to each salmonid species present or presumed to occur at the site. A priority index (PI) rating is generated for each barrier through a Priority Index Model created by WDFW. The PI is based on cost, species utilization, and habitat gain. The habitat gain is determined by measuring gradient, stream-wetted and ordinary high water widths,

substrate composition, riffle-to-pool-to-rapid ratios, juvenile abundance, canopy cover, instream cover, flow, temperature, and spring water influence. In order to identify the productive capability of the stream for the PI Model, Habitat Quality Modifiers (HQM) are assigned to each reach within the survey (Table 1). The HQM rating is used as a multiplier of the habitat area to obtain H in the PI model (H= habitat quality modifier x habitat in square meters). A complete explanation of the PI Model is in Appendix C.

The production potential of the stream is determined as square meters available for spawning and rearing habitat. Species that generally do not rear in streams and therefore are spawning habitat limited include: chum salmon (*Oncorhynchus keta*), sockeye salmon (*O. nerka*), and pink salmon (*O. gorbuscha*). Species that are dependant on streams for rearing include: Chinook salmon (*O. tshawytscha*) and coho salmon (*O. kisutch*); cutthroat trout (*O. clarki clarki*), steelhead and rainbow trout (*O. mykiss*), bull trout (*Salvelinus confluentus*), brown trout (*Salmo salar*), and brook trout (*Salvelinus fontinalis*).

Table 1. Criteria Used to Assign Habitat Quality Modifiers (HQM) to Rearing and Spawning Habitat

Habitat Condition	**HQM Value**	**Rearing Habitat Criteria**	**Spawning Habitat Criteria**
Good to Excellent	1	Rearing habitat is stable and in a normal productive state with all components functional	Spawning gravel patches have ≤ 16% fine particle sizes that are <0.85mm in diameter
Fair	2/3	Rearing habitat shows moderate/widespread signs of instability and/or disturbance known to reduce productive capability (one or more habitat components missing or significantly reduced presence)	Spawning gravel patches/riffles show moderate/widespread signs of instability (scour/filling) and/or >16% and ≤21% fine particle sizes <0.85mm in diameter
Poor	1/3	Rearing habitat shows signs of major/widespread disturbance likely to cause major reductions in its production capabilities (two or more habitat components missing or severely reduced presence)	Spawning gravel patches/riffles show major/widespread signs of instability (scour/filling) and/or >21% and ≤26% fine particle sizes <0.85mm in diameter
No Value	0	Rearing habitat severely disturbed so that production capabilities are without value to salmonids at this time	Spawning gravel patches with > 26% fine particle sizes < 0.85mm in diameter

We utilized the full physical survey methodology, as this provides the most reliable information about the habitat upstream and downstream of the barrier. Measurements were taken on 30 m for every 160 m of stream length if the total stream length was less than 1.6 km. Measurements were taken on 60 m for every 320 m of stream length if the total stream length was greater than 1.6 km. Also, prior to performing the upstream physical habitat survey, the stream channel downstream of the assessment site was checked in order to determine if there were any fish passage barriers present. A hip chain was used to measure total distance while walking upstream, and a laser level was used to obtain a more accurate stream gradient reading than could be obtained by using clinometers.

After completing barrier assessments on all the Service lands in WRIA’s 1-23, habitat assessments were initiated at three barrier locations. A full physical habitat survey of the Big Quilcene River upstream of the Quilcene NFH was conducted in order to generate a PI number. Of the six barrier dams, the only dam without a means for fish passage during low flows was the Quilcene NFH electric weir because the ancillary fish ladder is inoperable. It was for this reason that habitat surveys were conducted on the Big Quilcene River. Additionally, a modified physical habitat survey was conducted on two Cook Creek tributaries with barrier culverts. The modified physical habitat survey on the Cook Creek tributaries entailed walking approximately 100 m upstream of each culvert in order to determine bankfull channel widths and channel slopes for use in the stream simulation model. We also incorporated into this report the full physical habitat assessment data and PI number for Penny Creek that WDFW surveyed and generated in 1998 (Till et al. 2000).

Overall Results

A total of 68 sites were visited, which included all potential fish passage barriers on Service-owned property in WRIA’s 1-23. Of these sites, 13 culverts and 6 dams were found to be partial or complete barriers. Total features evaluated were 47 culverts (2 with tidegates), 8 dams (3 had electric weirs), 4 fish ladders, 4 gravity diversions, 1 pump diversion, and 4 as other (Tables 2 and 3).

Table 2. Total Features Evaluated on Service lands in WRIA’s 1-23

Feature	Non-fish Bearing	Barrier	Passable	Unknown Passability	No Status for Passability	Total
Culverts	19	13	1	14	0	47
Dams	0	6	2	0	0	8
Fishways	0	0	0	0	4	4
Gravity Diversions	0	0	0	0	4	4
Pump Diversions	0	0	0	0	1	1
Other	0	0	4	0	0	4
Total	19	19	7	14	9	**68**

Table 3. Status for Features Evaluated on Service lands in WRIA's 1-23

Site	Non-fish Bearing	Barrier	Passable	Unknown Passability	No Status for Passability	Total
Dungeness NWR	0	0	0	0	0	0
Nisqually NWR	3	10	0	11	0	24
Black River Unit	3	0	0	0	0	3
Grays Harbor Unit	0	0	2	0	0	2
Quinault NFH	7	4	2	0	2	15
Quilcene NFH	1	3	2	0	2	8
Makah NFH	3	1	0	1	2	7
Nisqually FHCC	2	1	1	2	3	9
Total	19	19	7	14	9	**68**

Hatchery Facilities

Makah National Fish Hatchery

Introduction

The Makah NFH was established in 1981 to restore salmon resources of the Makah Indian Reservation and nearby watersheds on the north Washington coast and the Strait of Juan de Fuca (Zajac 2002). The Makah NFH is located at river kilometer (RK) 4.8 on the Sooes River, and has a nonconsumptive water right of about 50 cubic feet per second (cfs) for fish culture and domestic purposes (DOI 1975).

The Sooes River originates in the foothills of the northwest slope of the Olympic Mountains. The river flows west through privately owned timberlands until it reaches the Makah Indian Reservation at RK 6.7. The mainstem Sooes River is approximately 25.6 km long and has approximately 62.4 km of conjoining tributaries. On the mainstem, at RK 22, there is an impassable waterfall and it is reported that salmonids use 22.4 km of the tributaries (Zajac 2002). The Sooes River watershed was heavily logged during the 1970's, which has resulted in poor natural large woody debris (LWD) recruitment (Zajac 2002). This lack of LWD has negative impacts on spawning and rearing.

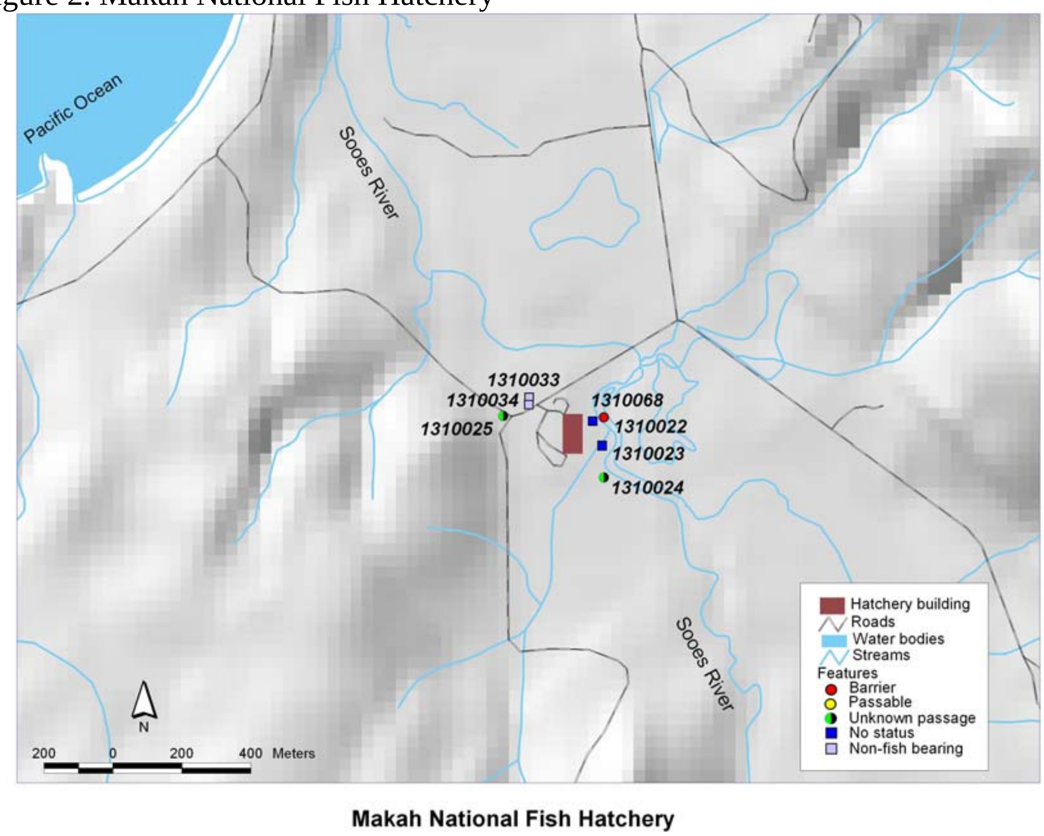
The current fish production program at Makah NFH releases fall Chinook salmon, coho salmon, and steelhead into the Sooes River each year (Zajac 2002). If available, the hatchery will pass up to 473 adult fall Chinook and 1,610 adult coho if egg collection goals are likely to be met (Zajac 2002). The hatchery also passes all chum and pink salmon, and cutthroat trout.

Survey Results

We conducted our surveys, in cooperation with Makah NFH staff, on August 19 and 29, 2003. Our survey identified a total of seven sites of interest throughout the Makah NFH property. Hatchery infrastructure that was assessed for fish passage included: access road; Sooes River electric weir; Sooes River water intake; hatchery fish ladder; and effluent culvert (Figure 2).

<u>Sooes River electric weir</u> The Makah NFH has an electrified/concrete weir that spans the entire channel of the Sooes River (Appendix A, p. 49). This weir is used to prevent returning adult salmon from passing the hatchery and to entrain them into the hatchery's fish ladder. The weir is not a physical block to fish movement during a combination of high flow and high tide, or when the electric field is turned off (Zajac 2002). The electric field is created when an electrical current is passed through a series of probes which are suspended from an overhead cable and ground wire that spans the river. The electric field is activated from October through March (Jensen, Al, Service, Pers. Comm., 2003) when needed to divert fish into the hatchery. However, Al Jensen (acting Hatchery Manager) informed us that to accommodate a native run of steelhead, the weir is turned off about March 1 to allow upstream fish passage. Also, in order to assist passing juvenile salmonids and adult steelhead trout downstream during low flow conditions a 0.9 m wide slot concentrates water over the left bank side of the electric weir (Zajac 2002).

Figure 2. Makah National Fish Hatchery



Hatchery fish ladder   On the left bank, just downstream from the concrete and electric weir, is the entrance to the fish ladder (Appendix A, p. 144). The fish ladder contains 23 step pools and 21 slotted weirs. During our survey the fish ladder was dry; however, we estimated the approximate pool head difference to be at 0.3 m. The 21 slotted weirs have alternating (left or right) notched corners at the top of each weir, as well as at the base of each weir. These notches allow for water to pour into the downstream pools and create better hydraulics for fish passage. At the top of the fish ladder is an optional diversion feature that allows the hatchery staff to pass fish from the fish ladder to the Sooes River just above the weir. The fish ladder on the right bank side of the weir is only intended to pass fish up into the hatchery, and was evaluated as non-fish usage for the purposes of this assessment.

Sooes River water intake   The concrete and electric weir impounds water, which is diverted from the pool via a pump house and distributed throughout the hatchery. The pump house intake is located upstream from the weir on the left bank (Appendix A, p. 51). There is a large metal grate connected to an angled concrete wall and the pump house that prevents large debris from entering. This connection forms a protective area from which debris-free water can be diverted for the hatchery. Adjacent to this protected area, there are four gate valves on the lower section of the pump house in front of the pump intake. The gate valves control the amount of water flowing into the pump house. The pumps inside the pump house also have screens of woven mesh to prevent debris and fish from being drawn into the pumps.

Access Road   The access road to Makah NFH crosses over a small drainage associated with a seasonal wetland. This crossing contains a 12.12 m long culvert with a span and rise of 1.2 m and 1.25 m, respectively (Appendix A, p.55). This drainage was completely dry during our survey, however Al Jensen informed us that prior to 2003, and during his 5 years at the hatchery he had never seen it without water. We noted that this culvert appears to experience high water velocities since the presence of a plunge pool and rust lines indicate high flow levels within the culvert, and no streambed material was present in the culvert. The culvert slope was 0.25%, however fish passability is unknown because a downstream control was inaccessible.

Effluent culvert   Under normal operating conditions, raceway effluent water flows from the raceways through a 76 m long, 1.5 m diameter reinforced concrete pipeline into the pollution control pond (PCP) and a 1.6 km long meandering channel before it enters the Sooes River at the base of the fish ladder. However, for two or three weeks during mid-summer, when the hatchery is experiencing extremely low river flows, the effluent water is diverted into the Sooes River above the river pumphouse. Except for this short time period, the effluent water is sent through an approximately 6 m long culvert with a 0.4 m diameter, located approximately 10 m off the left bank side of the Sooes River upstream of the hatchery intake (Appendix A, p.53). The water flow is regulated on the upstream opening of the culvert by a metal and concrete gate. This gate opening is approximately 1.5 m and was open 0.5 m during our survey. The downstream end of the culvert was under approximately 0.8 m of water at the time of the survey. Annually, a very limited number of hatchery steelhead and coho fry (which are excess to production needs) are placed into the PCP for natural rearing and outmigration (Jensen, Al, Service, Pers. Comm., 2003). Upon smoltification the fish pass from the PCP through the meandering channel into the Sooes River. The culvert also looks physically passable when the gate is open, but it is not intended for fish to pass and enter the effluent channel or ponds. The slope was not taken on this culvert because the upstream concrete/metal gate made it impossible to access the actual culvert. The culvert was evaluated as a non-fish bearing structure.

We also located two small culverts most likely used to drain rain and flood water from a field adjacent to the hatchery facilities to the Sooes River (Appendix A, p.74 and 76). Neither culvert seemed to be located in a stream, as there was tall grass growing around the two culverts and neither culvert contained water. Al Jensen informed us that occasionally the field was subject to flooding. We found evidence of past floods nearby. However, we believe these two culverts were in areas of no fish use and therefore had no impacts on fish passage.

Quinault National Fish Hatchery

Introduction

The Quinault NFH is located on Cook Creek 7.2 km upstream from the confluence with the Quinault River at RK 26.4. The hatchery was established in 1968 in order to "restore and enhance depleted runs of salmon and steelhead on the Quinault Indian Reservation and adjacent federal lands…" (Zajac 2002). The Quinault NFH acquired the following water rights: 50 cubic feet per second (cfs) on Cook Creek; 0.23 cfs on an unnamed spring; and 10 cfs on Hatchery Creek.

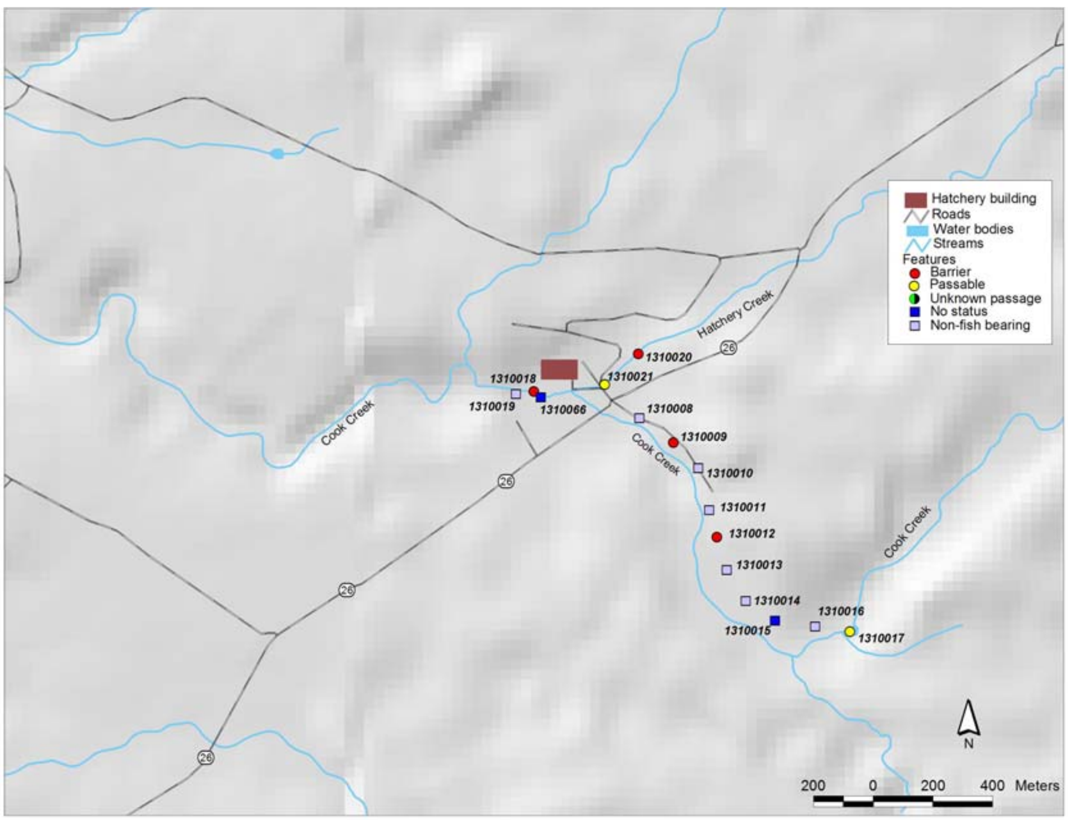
Cook Creek is approximately 20.5 km long with 40 km of tributaries. Originating in the Olympic Mountains, Cook Creek runs through a mix of U.S. Forest Service, Rayonier Timber, and Quinault Indian Nation lands. Historically much of this land was managed for timber production, and is composed of even-age single story conifer trees; primarily Douglas fir (*Pseudotsuga menziesii*) and western hemlock (*Tsuga heterophylla*), with red alder (A*lnus rubra*) in the riparian areas. With the exception of the headwaters, stream gradient throughout the creek is less than 2%. Habitat quality in Cook Creek is good, with abundant spawning gravels and large woody debris. Multiple tributaries and wetlands provide rearing habitat for juvenile salmonids. Prior analysis of the creek indicates that the reach most likely experiences a flashy hydrologic pattern, providing high sediment transport capacity during brief, but frequent floods (Zajac 2002).

Salmonid species documented for Cook Creek and the Quinault River are Chinook, coho, chum, pink, and sockeye salmon, and steelhead, cutthroat, and bull trout. Current hatchery production includes the following: fall Chinook, coho, chum, and winter steelhead. No adult or juvenile fish are actively passed over the electric weir; however, some adults have passed over during power outages and high flow events. Resident cutthroat and rainbow trout use the creek above the hatchery. Some juvenile coho were captured above the hatchery in 1997, indicating that adults had successfully moved and spawned upstream.

Survey Results

On August 18, and September 15, 2003, we surveyed the hatchery facilities with assistance from Dave Zajac, Western Washington Fish and Wildlife Office (WWFWO) Fish and Wildlife Biologist. Hatchery infrastructure that was assessed for fish passage included the following: Sockeye Road; Intake Road; Cook Creek intake and dam; Cook Creek electric weir with bypass; and the Hatchery Creek intake and dam (Figure 3). The hatchery facilities present a number of barriers to upstream fish migration. The electric weir on Cook Creek, and the Hatchery Creek intake and dam are intentional barriers for hatchery production purposes.

Figure 3. Quinault National Fish Hatchery



Quinault National Fish Hatchery

<u>Cook Creek electric weir with bypass</u> The hatchery weir and associated fish ladder and bypass structures are located at RK 7.2 on Cook Creek (Appendix A, p.39). The weir at the hatchery would not physically block fish if the electric field was turned off, but the weir is currently electrified year round, which makes it a full barrier to fish passage. The weir has electrodes set in a concrete base and is level with the streambed. A bypass of the same design, which is also electrified year round, is located between the weir and the

hatchery fish ladder on the right bank side of Cook Creek. The bypass can be turned on and off separately from the weir to allow fish passage upstream. The fish ladder on the right bank side of the weir is only intended to pass fish up into the hatchery, and was evaluated as non-fish usage for the purposes of this assessment (Appendix A, p.140).

A small culvert located on the right bank directly downstream of the weir serves as a ditch drainage, but periodically adult salmonids get up into this ditch and are stranded (Appendix A, p.41). **A temporary grate** in front of the culvert during spawning seasons would prevent this.

<u>Hatchery Creek intake and dam</u> Approximately 150 m upstream of the electric weir on Cook Creek is the confluence with Hatchery Creek. Approximately 100 m upstream on Hatchery Creek is the diversion dam for hatchery water (Appendix A, p.43). Hatchery Creek provides water that is free of regulated pathogens for the egg incubation process. The dam spans the creek, with the intake screen on a quarter of the right bank side set 0.1 m lower than the top of the dam. Water crests over the top of the screen which is slanted down towards the creek so fish and debris may be passed over the top of the screen. There are a number of wooden planks set into the middle of the dam, next to the screen. These planks can be removed or replaced according to water levels, with their main purpose being sediment release from behind the dam. Alternatively, they could also be removed to allow fish passage above the weir. Currently, there is a 1.4 m drop from the top of the dam to the water surface, so the dam is a barrier to upstream fish migration.

<u>Sockeye Road</u> Approximately 100 m downstream of the Hatchery Creek intake is a double culvert that runs under Sockeye Road, which is owned by the Service (Appendix A, p.46). This culvert is about 40 m upstream from the Hatchery Creek confluence with Cook Creek. The culverts are spaced 1.5 m apart, and both have streambed material throughout their length. With a combined culvert/toe ratio greater than 0.75, they are considered to be fully fish passable by TAPPS manual protocol. The Stream Simulation Model cannot be applied to multiple culverts, so it was not used in this situation. The intake and dam located upstream from these culverts may create periodic abnormal flows and sedimentation within lower Hatchery Creek, but the bed material within the culverts appears fairly stable. However, a double culvert has a greater potential for catching debris and becoming plugged, potentially causing a mass wasting event. Therefore, **we recommend** replacing this culvert with a bridge or an adequately sized culvert that meets stream simulation design criteria, although replacement of these culverts is not required in order to provide fish passage.

<u>Cook Creek intake and dam</u> The main hatchery intake and dam is located at RK 8 on Cook Creek. A concrete dam spans the majority of the creek (Appendix A, p.36). The intake pipe is on the right bank side of the creek, next to the fish ladder for the dam (Appendix A, p.32). At low flows, all creek water is diverted into the intake pipe, which travels approximately 100 m downstream into a concrete pre-settling basin that contains a series of metal screens. Fish and debris are passed over the screens, and drop back into Cook Creek. The creek is essentially dewatered during low flows from the dam down to this outlet point, except for some water contributed by a left bank tributary 100 m below

the dam. The entrance to the intake pipe at the dam has metal grates that are slanted at a 45-degree angle from the water flow to discourage fish from entering.

There is no water cresting the dam or entering the fish ladder at low flows. The fish ladder has five weirs. Three are removable wood weirs and the two-tiered concrete dam forms the last two steps. No wood weirs were in place at the time of the survey, but the pool head difference would be 0.30 m if weirs were in place. There is a valve on the fish ladder for flow and sediment release. This valve is opened during high flows, and could also serve as a point for fish passage through the dam. According to TAPPS manual protocol, we did not evaluate the dam as a barrier because there is a fish ladder attached. At low flows, the dam and fish ladder appear to be a complete barrier to fish, but at high flows the dam is passable when the fish ladder is operational.

<u>Intake Road</u> Intake Road runs along the right bank side of Cook Creek for 0.8 km, ending at the hatchery intake and dam. There is an artesian well halfway down the road that supplies water for local residents, including hatchery and housing domestic water. The excess artesian water flows out from the hillside, and then runs adjacent to the road into Cook Creek. There are eight culverts along this road, but only culverts 1310009 and 1310012 are on potential fish bearing streams. These two culverts are partial fish passage barriers because there is no streambed material within, the outfall drop is greater than 0.24 m, and the slopes are greater than 1%.

Intake Road Recommendations

All eight culverts along Intake Road are scheduled to be replaced in the summer of 2004. Two of eight culverts, 1310009 and 1310012 are on potential fish bearing streams and are partial fish barriers. As these two culverts are located at the confluence with Cook Creek, the stream simulation model would not work because the required downstream grade control is not feasible.

Therefore, we used the WDFW no-slope design option which allows grade control to be addressed upstream of the culvert. The no-slope design requires the culvert diameter to be equal to 1.25 times the bankfull channel width. Any culvert shape can be used for the no-slope design option, but it must be countersunk a minimum of 20% at the downstream end, and a maximum of 40% at the upstream end. However, the squash or arch culvert design is a better alternative to a circular culvert for these two culvert replacements as there is only 1 m of road fill above each culvert currently.

<u>Culvert 1310009</u> At the outlet for culvert 1310009, there is a total vertical drop of 0.7 m over a horizontal distance of 1.7 m of riprap grade controls (Appendix A, p.20). The culvert slope is 1.14%. The bankfull channel width upstream of the culvert is 1.9 m; therefore, the culvert bed width (basically the culvert diameter) would need to be 2.4 m to meet the no-slope criteria. The existing culvert diameter is 0.46 m, and the scheduled replacement culvert diameter is 1.07 m. The preliminary survey of this stream indicated that there may be potential for channel incision above the new culvert if grade control is not installed. **Our recommendation** is to install a new 2.4 m wide squash or arch

culvert, set at a 0% slope, level with the Cook Creek stream bed elevation. Also, fish-friendly grade controls would need to be installed upstream of the new culvert. A longitudinal profile of this stream reach would be necessary prior to culvert installation, if grade controls are not installed, to determine the full potential for channel incision. Recommendations for avoiding channel incision on culvert replacement projects can be found in the "Geomorphologic Impacts of Culvert Replacement and Removal: Avoiding Channel Incision" (Castro 2003).

<u>Culvert 1310012</u> The scenario is similar for culvert 1310012, except that the culvert slope is 1.16% (Appendix A, p.26). The vertical drop at the outlet is 1.9 m over a horizontal distance of 4.2 m of riprap grade control. The bankfull channel width upstream of the culvert is 1.94 m. The existing culvert diameter is 0.46 m, and the scheduled replacement culvert diameter is 1.07 m. Based on this information, **we would recommend** a squash or arch replacement culvert with a 0% slope and a diameter of 2.4 m, with fish friendly grade controls upstream of the culvert. A longitudinal profile would be necessary if grade control is not placed in order to assess the potential for channel incision.

Quilcene National Fish Hatchery

Introduction

The Quilcene NFH is located at RK 4.5 on the Big Quilcene River, at the confluence with Penny Creek. The hatchery was established in 1911, "…for the propagation of salmon and other food fishes…" on Hood Canal (Zajac 2002). The Big Quilcene River originates from the eastern slopes of the Olympic Mountains, and runs through Forest Service land down to RK 6.4. With the exception of the hatchery facilities, land ownership outside the Forest Service boundary is a mixture of public and private from RK 6.4 to the mouth. The Big Quilcene River is 30 km long, with 131 km of tributaries. With the exception of Penny Creek, many of the tributaries upstream of the hatchery are high gradient with little or no anadromous fish access. There are impassable falls on the Big Quilcene River at RK 12.2 that are at least 5 m tall. There are also numerous small falls and rapids between RK 8 and 9.6 that make anadromous fish passage nearly impossible. The City of Port Townsend has a diversion dam at RK 14.4, with water rights for up to 30 cfs (Zajac 2002). The Quilcene NFH has acquired the following water rights: 40 cfs on the Big Quilcene River; 25 cfs on Penny Creek; 0.2 cfs on Durdle Creek; 5 cfs on Walcott Slough; and, several well water rights.

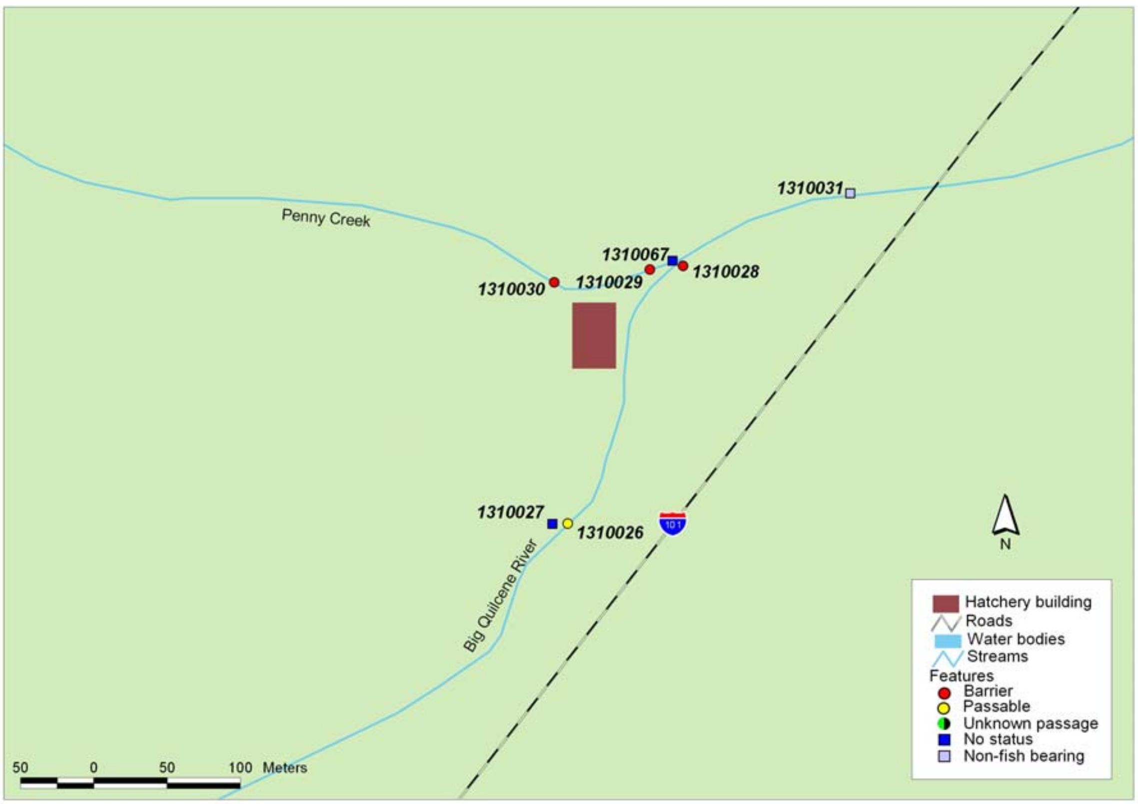
Salmonids that utilize the Big Quilcene River below the hatchery are coho, pink, summer and fall chum salmon, steelhead, and cutthroat trout. The hatchery currently raises coho, summer and fall chum salmon, however, the chum production program may end after 2003 per Hatchery Reform recommendations.

Penny Creek flows into the mainstem of the Big Quilcene River just below the electric weir. The only species documented for Penny Creek are cutthroat and brook trout. There is no written record of anadromous fish use of Penny Creek above the confluence of Penny Creek and the Big Quilcene River.

Survey Results

After conversations with hatchery assistant manager Larry Telles, we began surveys of the Quilcene NFH on August 20, 2003, with assistance from Dave Zajac, WWFWO Fish and Wildlife Biologist. Hatchery infrastructure assessed for fish passage included: Big Quilcene River intake and dam; Big Quilcene River electric weir; hatchery fish ladder; Penny Creek culvert; Penny Creek intake and dam; and effluent culvert (Figure 4). All current structures that present fish barriers are intentional fish barriers for hatchery purposes.

Figure 4. Quilcene National Fish Hatchery



Quilcene National Fish Hatchery

Big Quilcene River intake and dam The hatchery diversion dam and associated water intake and fish ladder are located at RK 5.3 on the Big Quilcene River. The concrete dam spans two-thirds of the river, with a small fish ladder wedged between the dam and the intake structure on the left bank side of the river (Appendix A, p.57). The dam is 1.0 m high, and during our site visit at low flows, water only flowed into the fish ladder and the intake. The river downstream of the dam and water intake is partially dewatered, creating a gravel bar over half the channel width. There is a low flow channel present adjacent to the gravel bar. The fish ladder has three weirs with vertical slots at the top of each weir. At low flows, the fish ladder is fully fish passable due to these vertical slots, which allow juvenile fish access above the dam.

The intake entrance has a log boom and metal bars spaced 0.10 m apart to prevent large debris from entering (Appendix A, p.60). The intake water travels through a 0.85 m diameter pipe to a presettling basin approximately 200 m downstream. Here, sediment settles out while fish and small debris are passed over or around rotating drum screens and are routed back by a 0.85 m diameter pipe to the Big Quilcene River. The fish, debris, and water re-enter the mainstem 50 m upstream from the electric weir, forming a small side channel on the left bank side of the river. The intake is not a fish barrier; however at low flows, it would be an impediment to fish that are entrained back downstream.

<u>Big Quilcene River electric weir</u> An electrified concrete weir was built adjacent to the hatchery in 1990, replacing an electric weir with hanging probes which was installed in the 1950's. Prior to the 1950's, a wooden stake weir diverted returning adults into the holding pond.

When turned off the electric weir acts as a full physical block during low flows; however, an ancillary fish ladder is present. The weir is also a barrier when the electricity is turned on during the first high water event while coho are running, from approximately October 1. The weir is turned off, or de-electrified, after the fall chum runs end in early January. There is full adult fish passability after January 1 for steelhead, cutthroat, and rainbow trout. Between 230 and 599 adult coho salmon from throughout the run are passed intentionally upstream of the weir by hatchery personnel. Occasionally, adult chum or coho may get past the weir during a combination of high flows, power outages, and other failure of the electric weir (Zajac 2002). The electric weir at the hatchery has a 1.5 m long slanted concrete surface with a slope of 2.5%, and two vertical drops (Appendix A, p.62). The vertical distance from the top of the weir to the slanted surface is 0.45 m, and the vertical distance from the bottom of the slanted surface to the water surface is 0.60 m. At low flows, adult salmonids can navigate the first jump, but can not swim up the slanted portion. At high flows, the two vertical drops and the slanted portion of the weir become submerged, making it fully passable to adult salmonids if the electricity is shut off (Figure 5). The top of the weir has electrodes placed in the concrete that create a graduated current dependant on water levels passing over the weir (Zajac 2002). On the left bank side of the weir is an ancillary fish ladder that was inoperable and not fish passable because of accumulated sediment.

<u>Hatchery fish ladder</u> A second fish ladder, designed to bring adult salmonids up into the hatchery, is adjacent to the outlet of the Penny Creek culvert (Appendix A, p.142). Hatchery fish are imprinted on Penny Creek water, and therefore return to this fish ladder into the hatchery facilities. We evaluated this ladder as non-fish usage for the purposes of this assessment.

Figure 5. Electric weir at Quilcene NFH on 10/22/03, almost completely submerged during high flows. This is the starting point for the full physical survey on the Big Quilcene River.

Effluent culvert There is a small culvert downstream of the Big Quilcene electric weir that is located on the left bank side of the river next to the Highway 101 bridge supports (Appendix A, p.70). This culvert drains the pollution abatement ponds for the hatchery. The culvert has a rubber boot over the downstream end that closes when effluent pond flows are low. A metal grate has been placed over the front of the boot to prevent adult salmonids from entering the ponds. This culvert was evaluated as a non-fish usage structure.

Penny Creek culvert The Penny Creek culvert is at the confluence of Penny Creek with the Big Quilcene River (Appendix A, p.65). The culvert is 64 m long with a slight bend inside. The bottom of the culvert is covered in cement, and a small pipe connected inside the culvert returns a portion of hatchery water back to the creek. Hatchery fish imprint on this water from Penny Creek. The slope of this culvert is 2.47%, and the outfall drop is 1.0 m after water is passed over a screened concrete box. Any resident fish or debris are washed over the screen, where they drop into a concrete sluice that diverts fish into the Big Quilcene River. There is no physical access to the downstream end of the culvert and the culvert has zero fish passability. The water that flows through the screen is passed down a pipe and enters the Big Quilcene River at the base of the hatchery fish ladder.

The total drop in elevation from the Penny Creek presettling basin (located upstream of the Penny Creek culvert) down to the Big Quilcene River is 6.6 m over a distance of 140 m, which equals a 4.5% slope. If this reach was originally a series of cascades, there would have been potential anadromous fish usage for salmonids that could ascend a 4-6% gradient stream, specifically coho and pink salmon, steelhead and cutthroat trout. However, if a waterfall greater than 3.8 m high was present, then no anadromous salmonids would have been able to access habitat upstream. If fish passage were provided through this reach, there is potential for coho and steelhead to utilize Penny Creek based on its upstream physical characteristics. However, average gradients of 6%

in the first 2,500 m of Penny Creek make it unlikely that chum or pink salmon would be able to access this system.

Penny Creek intake and dam   Approximately 40 m upstream from the Penny Creek culvert is the Penny Creek intake and dam (Appendix A, p.67). This intake provides water that is free of regulated pathogens for the hatchery incubation process. A concrete dam fully spans the creek on the upstream side of the intake. There is a butterfly valve in the middle of the dam that can be opened or closed to release sediment from above the dam. The pond above the dam is also dredged periodically. The right bank side of the dam is connected to the intake structure. The intake screen slants down on top of a concrete box. Fish, debris, and some water are passed over the screen back down to the creek. Intake water runs through a welded steel pipe above the creek to the hatchery facilities. No fishway is attached to the dam. The drop from the top of the intake screen down to Penny Creek is 1.0 m, which presents a partial barrier to fish. The surrounding landforms suggest that historically there may have been a small cascade at this point on the creek. The gradient of the creek upstream and downstream of the intake is approximately 4-5%.

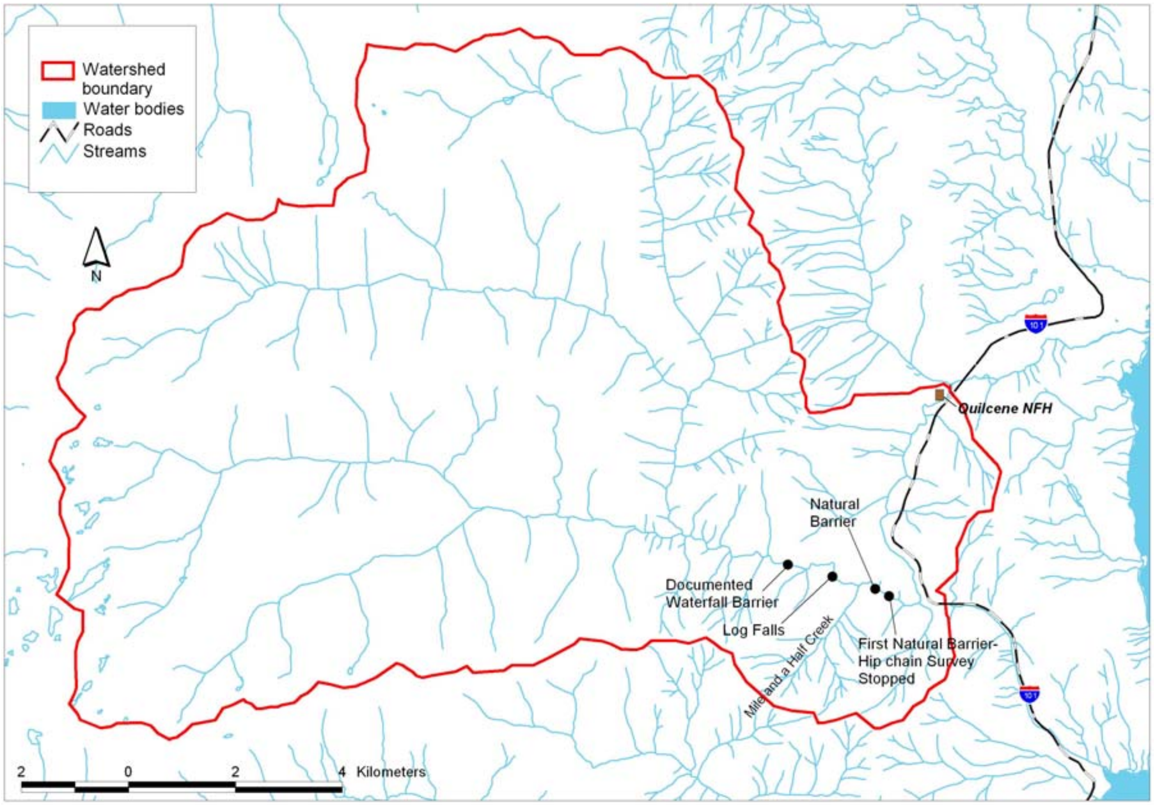
Walcott Slough   A satellite trap and haul facility of the Quilcene NFH is located approximately 19.2 km south along Highway 101, at Walcott Slough (Appendix A, p.72). It was used for chum processing up until 1988 when production spawning was stopped at this facility and transferred to the Quilcene NFH. A small spring runs under Highway 101, flowing into a series of estuary channels. The trap and haul structure is still in place on one of these estuary channels. Metal grating blocks the entire channel at low tide. The bars are spaced 0.10 m apart, so juvenile fish can pass, but at low tides an adult would be blocked. However, there are multiple channels around this feature, so it is not a barrier to fish passage.

Habitat Assessment- Big Quilcene River

Because the electric weir is a partial physical barrier to fish passage (Figure 6), we performed a full physical habitat survey of the Big Quilcene River upstream of the electric weir from September 16 through September 21, 2003. In this case, a downstream check was unnecessary because the Big Quilcene River is verified free of fish barriers from the hatchery down to where the river enters Quilcene Bay on Hood Canal. We surveyed 5,584 m of the river, up to a 4.5 m boulder waterfall that we could not get around (Figure 7). A large pool and the confined canyon walls prevented a close inspection of these falls. There could potentially be fish passage through the boulders and logs that we were unable to see. Nonetheless, the downstream 0.8 km were extremely confined, and filled with large boulder rapid and pool complexes. Any fish passage up to this point would be minor.

In general, the first 2.4 km of the Big Quilcene River upstream of the electric weir were characterized by wide channels with gradients ranging from 0.5% to 1.5%. Large woody debris was sparse, and much of what was available was engineered and placed by the Quilcene NFH above the diversion dam and water intake at RK 5.3. Canopy cover was

Figure 6. Physical Habitat Survey on the Big Quilcene River



Physical Habitat Survey for the Big Quilcene River

low, ranging from 20 to 50%. Substrates were predominantly gravel and small cobble, and riffle habitat was two to three times more abundant than pool habitat.

The river became more confined at RK 6.4, upon crossing the Olympic National Forest boundary. Substrates were predominantly cobble and boulder, resulting in a large amount of rapid and pool complex habitat (Figure 8). Canopy cover increased to 70%, as the canyon walls became more confined. At RK 9.1, Elbo Creek enters the mainstem from the right bank side. After this point, the physical survey continued for approximately 0.8 km until sheer canyon walls and deep pools prevented any further upstream ascent (Figure 9). We left the mainstem at this point, and re-entered the Big Quilcene River at Mile and a Half Creek to continue surveying upstream and downstream on the mainstem in an attempt to reach the documented impassable waterfall at RK 12.2. Impassable natural barriers prevented our passage upstream and downstream of the Mile and a Half Creek confluence with the Big Quilcene River. Our final stopping point at the uppermost barrier on the Big Quilcene River (Figure 10) was approximately 0.8 km downstream from the documented impassable waterfall at RK 12.2.

There were a total of 11 tributaries entering the Big Quilcene River between the electric weir at the hatchery, and the documented impassable waterfall at RK 12.2. None of these tributaries were surveyed, either because they were dry, or had steep gradients and/or waterfalls impassable to anadromous salmonids. Mile and a Half Creek has a 26 m high impassable waterfall approximately 150 m upstream from the confluence with the Big Quilcene River (Figure 11).

In general, there are moderate spawning and rearing opportunities within the first 3.2 km of the surveyed reach, although off-channel rearing habitat is negligible in the Big Quilcene River, except at high flows. A large amount of gravel has been deposited between approximately RK 5.3 and the mouth of the Big Quilcene River. This gravel originated from upstream sources throughout the watershed as a result of past logging practices. The Big Quilcene River experiences flash floods that can significantly and suddenly alter the stream channel, resulting in dewatering or scouring of spawning habitat. The upper reaches of the survey are most suitable for steelhead and cutthroat trout, with some potential for juvenile coho over-wintering use.

A PI number was computed using only the habitat surveyed up to the first barrier where the hip chain survey concluded. The PI was 59.70, which is relatively large (Appendix D). This is partially due to the variety of salmonid species that could potentially use the various reaches of the Big Quilcene River upstream of the electric weir. The large PI is also due to the low cost rating given to the fix for this barrier, as fish passage could be provided by making the ancillary fish ladder passable. However, if the project scope were to include the removal of the electrified concrete weir, then the cost increase would decrease the PI number to 45.36.

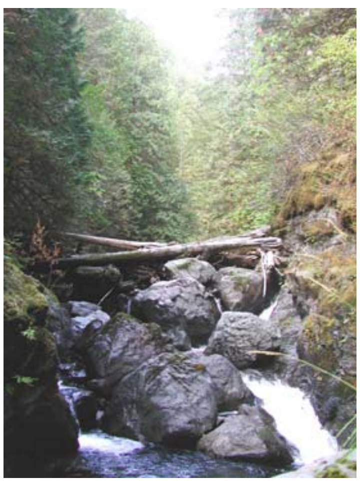


Figure 7. First natural barrier encountered at RK 9.9, hip chain survey stopped here

Figure 8. Example of habitat between RK 8 and RK 11.2

Figure 9. Habitat below first waterfall barrier, approximately RK 9.4

Figure 10. Log falls approximately 0.8 kilometers downstream of documented waterfall at RK12.1

Figure 11. Waterfall on Mile and a Half Creek, measures 26 meters high

Habitat Assessment- Penny Creek

A full physical habitat survey was performed by WDFW in 1998 on Penny Creek and its tributaries (Till et al. 2000). WDFW was conducting a survey of Jefferson County culverts in 1998, and had verified a number of barrier culverts upstream of the hatchery facilities on Penny Creek. With permission from the Quilcene NFH, WDFW began the full physical habitat survey at the Penny Creek culvert next to the Quilcene NFH entrance. The PI number generated for the Penny Creek culvert was 42.44. The WDFW survey results indicate that there is very good habitat on most of Penny Creek upstream of the hatchery facilities, particularly for coho salmon, and steelhead, cutthroat, and rainbow trout. The main limiting factor within the Penny Creek watershed upstream of the hatchery is the presence of several non-Service barrier culverts on the mainstem and tributaries.

Nisqually Fish Hatchery at Clear Creek

Introduction

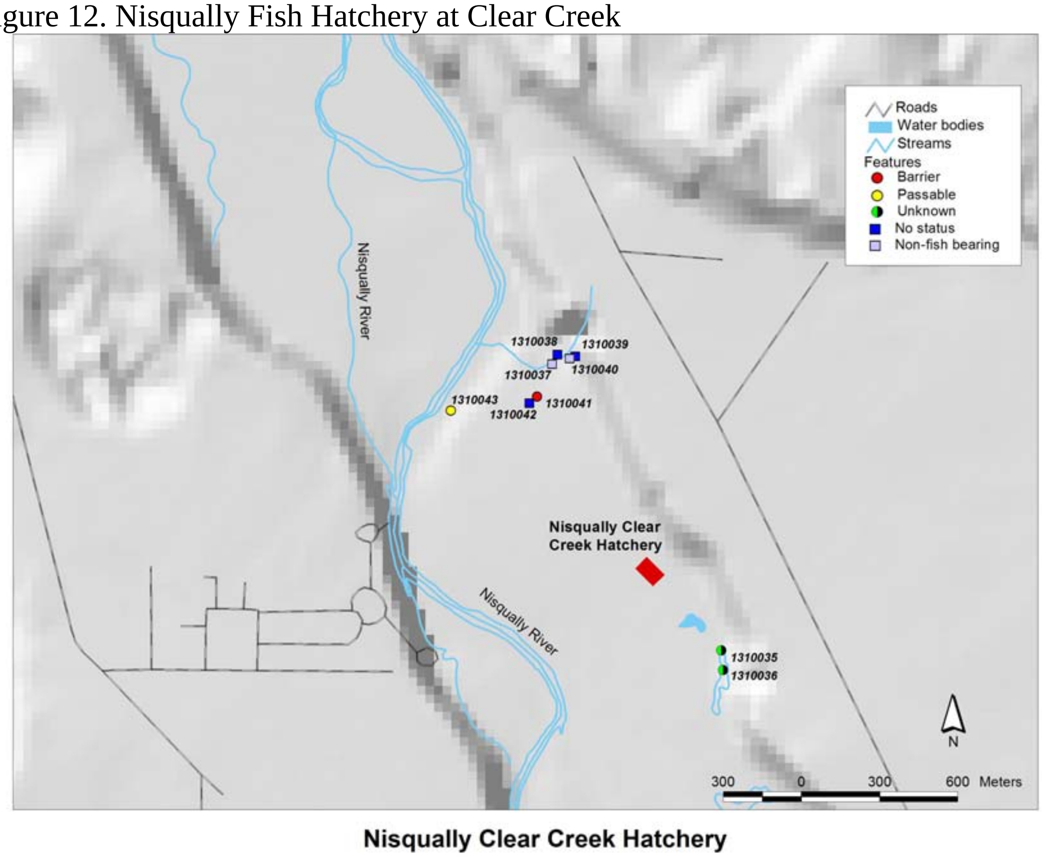
The Nisqually FHCC was established in 1991 under specific Congressional legislative authority and on land made available for the site under a lease agreement between the US Army/Fort Lewis and the Nisqually Tribe. The Nisqually FHCC is located on Clear Creek approximately 180 m upstream from the confluence with the Nisqually River, at RK 9.6. The U.S. Fish and Wildlife Service built and owns the Nisqually FHCC. The Nisqually Tribe operates the hatchery under an agreement with the Service and with funds from Tacoma City Light as mitigation for fish losses on the Nisqually River. The Nisqually Hatchery raises Chinook and coho salmon.

The Nisqually River originates from the Nisqually glacier on Mount Rainier. It flows 125 km before it enters South Puget Sound (HHC 1969). The Nisqually River produces runs of steelhead trout and Chinook, chum, pink, and coho salmon (SASSI 1992).

Survey Results

We conducted our survey at the Nisqually FHCC on September 9, 2003. We identified nine sites of interest: four culverts, one dam, two gravity diversions, one fish way, and one floating weir (Figure 12).

Figure 12. Nisqually Fish Hatchery at Clear Creek



The Nisqually FHCC's diversion dam is located on Clear Creek, approximately 100 m upstream from the confluence with the Nisqually River (Appendix A, p.90). The diversion dam is 50 m wide by 5.2 m high. An existing road abuts and is approximately 1 m higher than the concrete dam. On the upstream side of the road there is a concrete spillway box to allow high flows to pass over the dam. At the time of our survey, water from the dam reservoir was flowing over the top of the spillway and plunged approximately 3.5 m to the bottom of the spillway. The water then entered a 0.95 m diameter culvert under the road and then continued into Clear Creek on the other side. The diversion dam and spillway are a complete fish passage barrier. The Clear Creek confluence with the Nisqually River is at RK 9.6.

The Nisqually FHCC's fish ladder is located on the left bank side of Clear Creek, approximately 2 m downstream from the spillway culvert outlet (Appendix A, p.92). This ladder is solely used to allow adult salmon to enter the hatchery. The entrance of the ladder has no plunge pool or outfall, and connects directly into Clear Creek. The fish ladder has 14 wooden weirs with 15 weir pools. At the time of our survey, each weir was submerged except for the five uppermost weirs, which had a pool head difference of 0.30 m each.

The dam on Clear Creek creates a reservoir, which is crossed at two locations by service roads. Both service roads are at the far upstream end of the Clear Creek reservoir and both have culverts (Appendix A, p.78 and 80). During our survey both culverts were under water, which made them very difficult to locate and survey. The results of the surveys on these two culverts were inconclusive. We could not clearly locate the ends of the culverts to shoot a gradient and we could not determine if the culverts were filled in with sediment or debris. Both culverts were assessed as unknown for barrier status.

We also surveyed two other culverts that the hatchery maintained. One was a small, 0.20 m diameter pipe that was used to drain water from the nearby hillside and road (Appendix A, p.82). The other culvert surveyed was attached to a spring water intake dam (Appendix A, p.88). The intake dam (at Spring 3), creates a small pool, which the hatchery staff can divert into the hatchery holding ponds. The intake dam is 8 m wide by 2 m high, and the pool's maximum depth at the time of our survey was 1.7 m (Appendix A, p.86). Spring 3 seeps from the hillside directly into the intake pool, and there are also pipes draining water into the pool from upper springs. The intake culvert has a 0.93 m diameter. The downstream end of the culvert sticks out 4 m from the hillside and has an outfall drop of 1.07 m. The water then flows down the hillside into a wetland. There was no stream channel associated with the upstream or downstream end of this spring.

There is a small spring adjacent to the Spring 3 intake, with an additional intake dam used to divert water from the creek to a mitigated wetland created for over-winter rearing habitat (Appendix A, p.84). The intake dam is 12 m long by 2 m high. It contains a 1.53 m wide by 1.6 m high screen intended to primarily prevent debris from passing. Several valves are used to regulate flows from the intake. The creek upstream from the intake is very steep, approximately 10 to 15%, and most likely does not contain any fish. Connected to the intake is a pipe, with a 0.60 m diameter, that runs 120 m to a "beaver proof" box at the downstream end. The water depth inside the box was 0.9 m. The water flows from the box into the mitigated wetlands.

The Nisqually Tribe also owns a floating weir on a side channel of the Nisqually River to prevent returning salmon from bypassing Clear Creek (Appendix A, p.94). The weir is constructed of PVC pipes and an inflated float bag. The weir is anchored into the streambed at the upstream end with the float at the downstream end so it can pivot up or down as the river rises or falls. There is a 0.04 m space between the PVC pipes that can pass juvenile fish. The weir is operated from August 15 until December 15, when it is removed to allow wild spawning chum and steelhead to pass.

Refuge Facilities

Nisqually National Wildlife Refuge

Introduction

The Nisqually NWR is located at the southern end of Puget Sound, approximately 12.8 km east of Olympia. Established in 1974 as a part of the National Wildlife Refuge System, the refuge is managed under the legislated purpose for the protection and management of migratory birds. The current refuge approved boundary is 3,936 acres of mixed land ownership. Of this, 2,925 acres is currently owned and managed by the Service in accordance with the goals and policies of the National Wildlife Refuge System, and the purposes and goals of the Nisqually NWR.

A large portion of the Nisqually delta was diked in the late 1800's and early 1900's for farming. The 1,000 plus acre diked area is managed by the refuge as permanent and seasonal freshwater wetlands, marshes, grasslands, and riparian forest to provide feeding, resting, and breeding habitat for a wide variety of migratory birds, including waterfowl. The Brown Farm Dike surrounds the 1,000 plus acres. The Nisqually River, which originates from the glaciers of Mt. Rainier, flows along the east side of the dike, while McAllister Creek borders the west side. McAllister Creek originates at McAllister Springs and is almost completely tidally influenced due to a low stream gradient. The creek, along with a now defunct WDFW hatchery, provides spawning and rearing habitat for chum, coho, and Chinook salmon, and steelhead and cutthroat trout, as well as an occasional pink salmon. The Nisqually River provides spawning and rearing habitat for Chinook, coho, chum, and pink salmon, as well as steelhead and cutthroat trout. The estuary habitat provided by the undiked portion of the Nisqually delta is an important transition area for juvenile salmonids moving from these two river systems into saltwater.

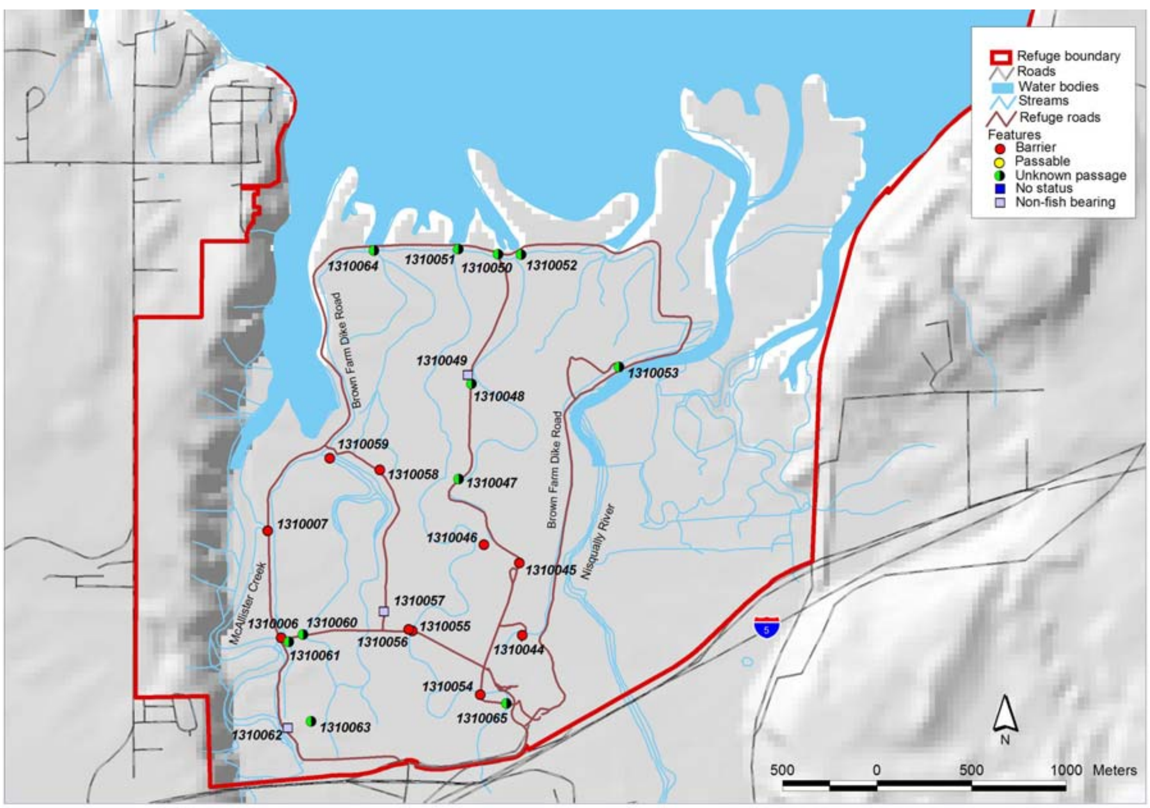
Nisqually NWR is in the process of developing a Comprehensive Conservation Plan to guide management of the refuge over the next 15 years. It includes a range of habitat management alternatives that consider restoration of portions of the diked area back to estuarine habitat. The Plan is expected to be completed in 2004.

Survey Results

Tidal gate culverts   The Brown Farm Dike was surveyed on August 7, 2003, and two tidal gate culverts along McAllister Creek were found (Appendix A, p.14 and 16). For tidally influenced culverts, an independent analysis of tidal influence and streamflow is needed (TAPPS 2000). The two tidal culverts had metal flap gates on the downstream side that are pushed shut by high tide, and partially open as the tide goes back out. Through verbal consultation, WDFW considers this type of tidal gate to be a barrier to fish passage since the flap gates rarely open completely to allow adult passage (Collins, Dave, WDFW, Pers. Comm., 2003). These culverts were encased within a concrete box on the upstream side, and were also completely blocked by wood plank risers so no exchange of saltwater could occur from McAllister Creek into the interior freshwater wetlands. Due to the current setup, there is zero fish passability for these two tidal gate culverts.

Interior culverts   In addition, on September 4, we surveyed 22 culverts within the dike (Figure 13), 19 of which had water control structures in place. Jean Takekawa, refuge manager, provided a map of some of the culvert locations to assist us in finding these features. The interior dike was assessed by driving and walking through all potential areas of concern.

Figure 13. Nisqually National Wildlife Refuge



Nisqually National Wildlife Refuge

Of the interior culverts, there were 5 barrier culverts due to attached wood risers (Appendix A, p.96, 118, 120, 124, and 126); 3 barrier culverts due to slope and outfall (Appendix A, p.98, 100, and 116); 11 culverts of unknown barrier status because a downstream control was inaccessible, or the culvert was submerged due to wetland influence (Appendix A, p.102, 104, 108, 110, 112, 114, 128, 130, 134, 136, and 138); and 3 culverts that were located in non-fish bearing drainage ditches (Appendix A, p.106, 122, and 132).

The five culverts determined to be barriers due to attached wood risers would have an unknown barrier status if the risers were removed, since there was streambed material throughout. According to TAPPS manual protocol, when there is streambed material throughout a culvert, the toe of the stream is compared to the diameter of the culvert. However, the Nisqually NWR is a network of sloughs without natural stream characteristics, so a toe measurement cannot be obtained and a Level B analysis is impossible (see Level A and Level B flow chart, Appendix B). Habitat assessments for barrier culverts were not conducted within the refuge because there were no natural stream channels to assess, only interconnected wetlands and sloughs that make the determination of upstream versus downstream habitat impossible.

The interior watercourses within the Brown Farm dike reflect some of the original estuary channelways. However the interior is now almost entirely freshwater. A small amount of saltwater seepage occurs through the dike, and on occasions of extreme winter flood events, the eastern dike has been breached by the Nisqually River. The vast majority of the interior freshwater is provided by a number of artesian wells and rainwater. A pump and well are used to enhance freshwater wetlands for wintering migratory birds. The movement of water between various wetlands and slough channels is managed by the presence of water control structures, and the placement and removal of boards (wood plank risers at the upstream end of the culverts) by refuge personnel. These watercourses are maintained to provide freshwater habitat for migratory birds and waterfowl, and since no comprehensive fish surveys have been conducted for the dike interior, we assessed all structures within the dike as unknown for fish presence. Using the WDFW criteria, fish presence at each site is evaluated as *potential* presence, if the habitat above were made accessible. The barrier assessment is not necessarily intended to identify whether or not fish are currently using the habitat.

Grays Harbor Unit of Nisqually National Wildlife Refuge (Bowerman Basin)

Introduction

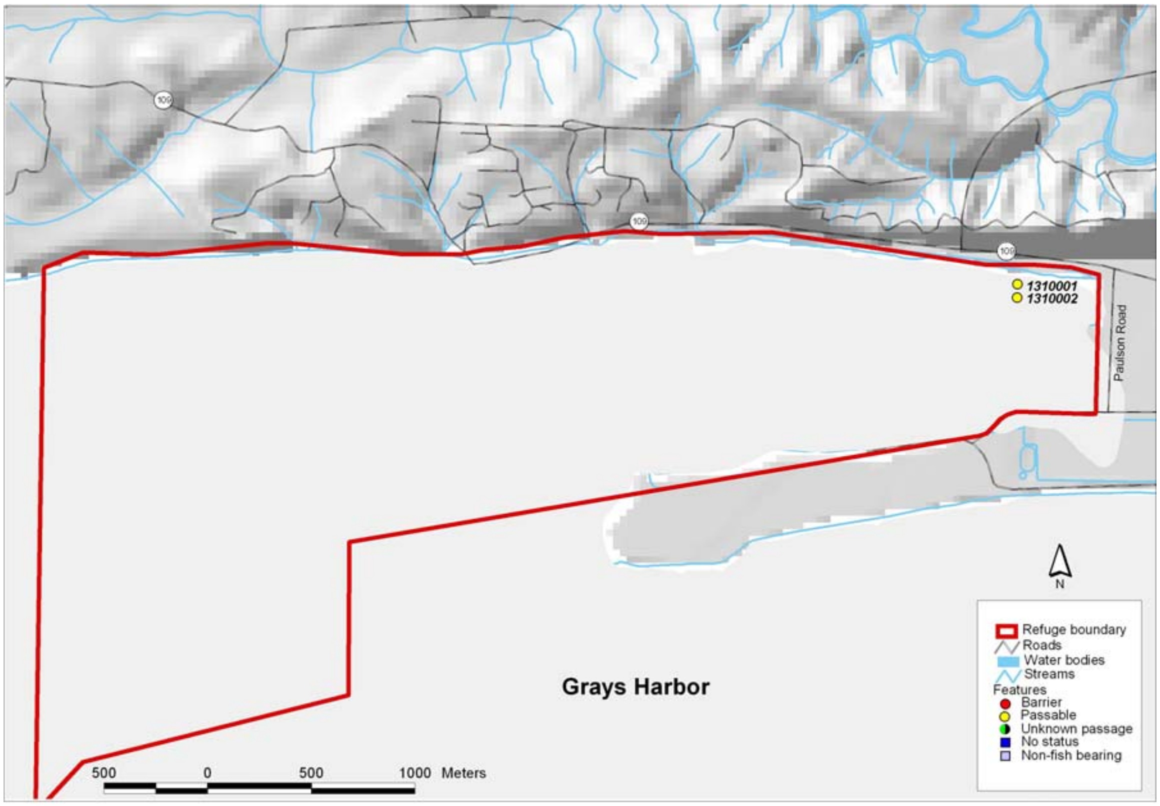
The Grays Harbor NWR was established in 1990 to protect an important shorebird staging area for Pacific Flyway migrants. It is located in the northeast corner of the Grays Harbor estuary, between the mouths of the Chehalis and Humptulips Rivers. The refuge encompasses 1,487 acres of tidal mudflats, salt marshes, and upland deciduous forest habitat. A 2.4 km elevated boardwalk trail runs along the southwest portion of the refuge. Through lease agreement, public access is allowed through the adjacent airport property out to the boardwalk trail for shorebird viewing. Several small unnamed streams flow through the refuge property, and fish usage within these is undocumented. However, due to the proximity to the Chehalis River, and Grays Harbor, there is potential for juvenile salmonid usage in this estuary habitat. Chinook, coho, and chum salmon, and steelhead, coastal cutthroat, and bull trout may utilize these small tributaries for rearing habitat.

Survey Results

A site visit was conducted August 5, 2003, after conversations with Nisqually NWR manager Jean Takekawa revealed a potential fish passage barrier in an interior dike. Within the eastern half of the refuge, a small dike runs in a northwest to southeast direction. The dike has been breached at two points (Figure 14) where small unnamed tributaries flow through (Appendix A, p.4 and 6). Downstream of each breach, there are small wooden footbridges that are anchored with wood footings alongside both banks. There is no sign of erosion around the backside of these footings, the banks appear very stable, and the streams have retained a constant meander pattern upstream and downstream of the dike. This portion of the two streams is tidally influenced, with a small trickle of freshwater during low tide at the time of the site visit. The footbridges are not a barrier to fish passage. There are no structures that affect fish passage along the wooden boardwalk trail.

Approximately 500 meters upstream of the footbridges, outside of the refuge boundary, there are two culverts under Grays Harbor County's Paulsen Road. These culverts along with partially submerged wood control structures that span each channel upstream of the culverts look like potential fish barriers. However, we did not conduct a fish passage assessment on these culverts as they are not on Service owned lands.

Figure 14. Grays Harbor National Wildlife Refuge



Grays Harbor National Wildlife Refuge

Black River Unit of Nisqually National Wildlife Refuge

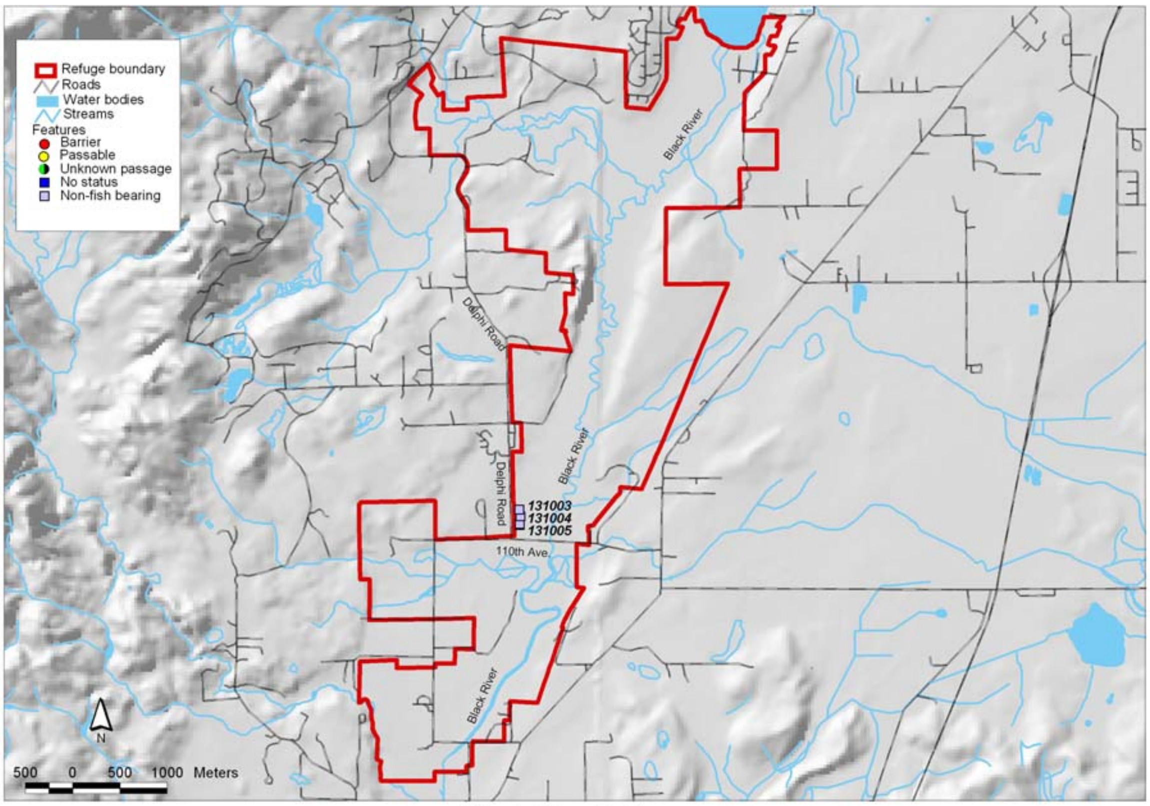
Introduction

The Black River Unit of Nisqually NWR was established in 1996 to protect spawning and rearing habitat for salmonids, and to protect habitat for migratory and residential waterfowl, wading birds, and other riverine and wetland dependent species. It is located in Thurston County, approximately 8 km southwest of Olympia. The refuge boundary encompasses approximately 3,800 acres, of which the Service owns and manages 800 acres. Refuge lands are primarily mixed lowland forest, wetland, riparian, wet prairies, upland fields, and abandoned farm properties bordering the Black River. The Black River is a tributary to the Chehalis River, and it supports spawning and rearing habitat for Chinook and coho salmon, and steelhead, rainbow and cutthroat trout (Phinney and Bucknell 1975). There are no tributaries to the Black River that flow through properties currently owned by the Service.

Survey Results

We initially spoke with Jean Takekawa, manager of the Nisqually NWR, and reviewed aerial photographs, to verify presence or absence of man-made structures on Service owned lands. We also surveyed all the Service lands by driving or walking through all properties of interest on August 6, 2003. In a dry field, within the flood zone of the Black River, we found three culverts placed in a line (Appendix A, p.8, 10, and 12) (Figure 15). There was no visible road, and the tops and sides of each culvert were exposed. A small amount of dirt and grass was growing within the culverts. These culverts may have been part of a drainage ditch when the farm was operational, or an old road that is no longer in existence. These culverts were evaluated as non-fish bearing. We found no other fish passage barriers within the refuge managed properties.

Figure 15. Black River Unit of the Nisqually National Wildlife Refuge



Black River Unit
Nisqually National Wildlife Refuge

Dungeness National Wildlife Refuge

Introduction

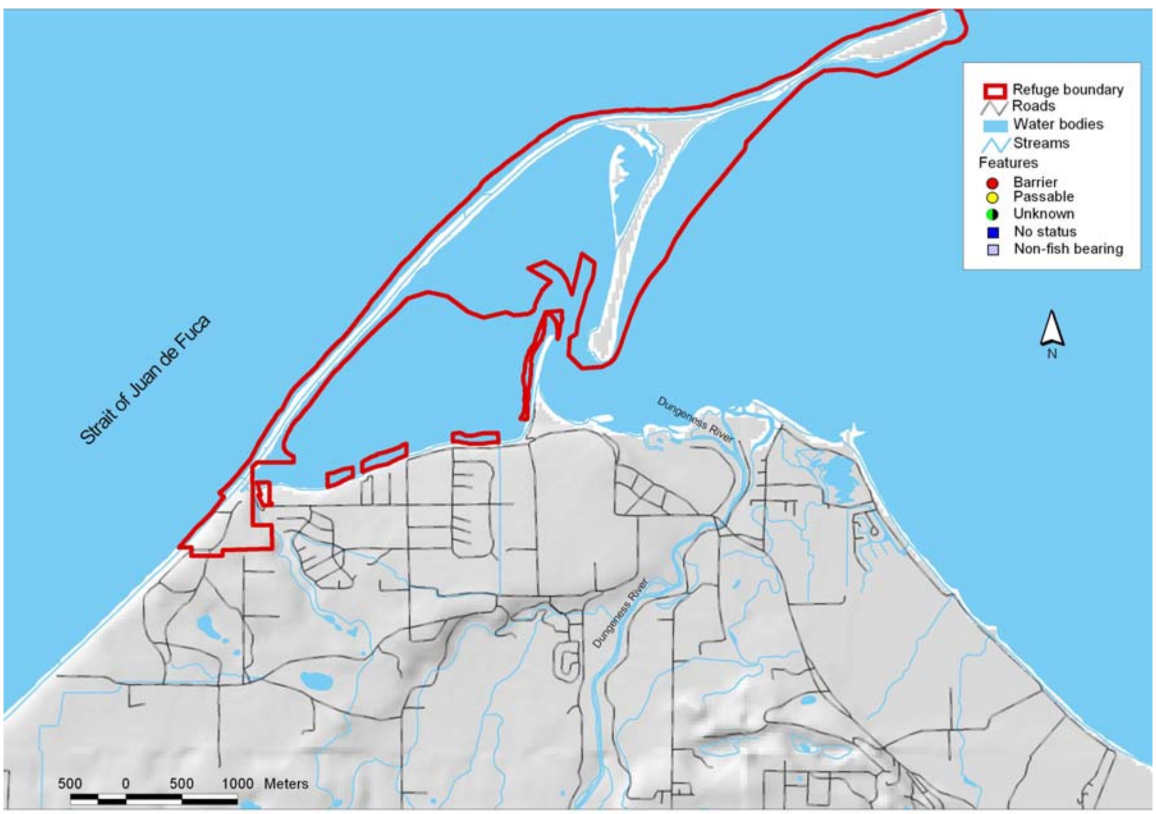
The Dungeness NWR is part of the Washington Maritime NWR, and is located on the southern side of the Strait of Juan de Fuca, in Clallam County. The Dungeness NWR encompasses 631 acres, including the Dungeness Spit, Graveyard Spit, and parts of Dungeness Bay. On Dungeness Spit, “the dominant wind and wave direction is from the west where sand, supplied by cliff erosion, is carried alongshore and deposited at the offshore end of the spit” (Downing 1983). Over a period of 130 years, the distal portion of the spit has continued to lengthen, growing at a rate of 4.4 m per year (Schwartz et al.

1987). The Dungeness River (which is one of the principal drainages in the northern Olympic Mountains) empties into the Strait of Juan de Fuca at Dungeness Bay. Chinook, coho, chum, and pink salmon, and steelhead, cutthroat, and bull trout all utilize the Dungeness River as well as the estuary habitats protected by the refuge.

Survey Results

Based on conversations with Kevin Ryan, the manager of the refuge and an assessment of the property on August 19, 2003, we verified there are no fish barriers in the Dungeness NWR (Figure 16). There is one small unnamed stream that drains into the bay, with a culvert just upstream of its mouth, on a private road. The neighboring property is within the authorized boundary for the refuge, therefore if the refuge acquires this neighboring property, the culvert would need to be surveyed.

Figure 16. Dungeness National Wildlife Refuge



Dungeness National Wildlife Refuge

Summary

The fish passage barrier assessment on Service owned properties in WRIA's 1-23 identified a total of 19 barriers. Of these barriers, 13 were culverts and 6 were hatchery dams. There were seven passable structures: one culvert, two dams, and four classified as other. A total of 14 culverts had an unknown barrier status. In general, this unknown barrier status was because many were connected to wetlands, so a downstream control was inaccessible. There were 19 culverts that were on non-fish bearing drainages that were not evaluated for fish passage. There were nine structures with no status: four fishways, four gravity diversions, and one pump diversion. According to the TAPPS manual protocols, fishways and screened water diversions are not evaluated for barrier status.

Of the 13 barrier culverts, 10 were within the Nisqually NWR. Habitat surveys were not conducted for the ten barrier culverts within the Nisqually NWR because the network of wetland sloughs within the refuge made it impossible to determine upstream versus downstream habitat. Two barrier culverts at the Quinault NFH are on schedule for replacement in the summer of 2004. The last barrier culvert was at Quilcene NFH on Penny Creek, which was surveyed for habitat by WDFW in 1998 (Till et al. 2000).

Of the six barrier dams, the only dam without a means for fish passage during low flows was the Quilcene NFH electric weir because the ancillary fish ladder is inoperable. It was for this reason that habitat surveys were conducted on the Big Quilcene River.

<u>Recommendations</u> We were able to make several recommendations in regards to providing passage at the following fish passage barriers:

(1) Quinault NFH - Cook Creek electric weir with bypass (p.15)
Install a grate (during salmon spawning seasons) on the drainage ditch culvert located downstream of the electric weir. This would prevent occasional adult salmonids from entering the ditch and becoming stranded.

(2) Quinault NFH - Sockeye Road (p.16)
Replace the existing double culvert with a bridge or an adequately sized culvert that meets stream simulation design criteria. The existing culvert is fish passable, however, a double culvert has a greater potential for catching debris and becoming plugged, potentially causing a mass wasting event.

(3) Quinault NFH - Intake Road culverts (1310009 and 1310012) (p.17 and 18)
Install a 2.4 m wide squash or arch culvert, set at a 0% slope, level with the Cook Creek stream bed elevation. Fish-friendly grade controls would need to be installed upstream of the new culvert. This recommendation has been provided to the Quinault NFH manager and the project engineer.

(4) Quilcene NFH – Penny Creek culvert (p.21)
Additional information is needed in order to determine whether fish passage into Penny Creek is desirable considering potential impacts to hatchery operations. If fish passage is determined to be desirable than a study would need to be conducted in order to determine the biological impacts, the engineered designs of feasible corrections, and the associated costs. A proposal to fund this study has been submitted to the Service’s Fisheries Operational Needs System in fiscal year 2004.

In summary, all culvert assessments and culvert habitat surveys were completed on Service owned lands in WRIA's 1-23 to address the anticipated first steps of the current *U.S.* v. *WA* sub-proceeding (*Boldt* culvert case). However, if it is determined that the refuges are responsible for fish passage on the nine properties with conservation easements, than the Service would need to conduct an assessment of these properties.

In addition to this fish passage assessment, the Service anticipates continued discussion of policies and legislated mandates pertaining to Region 1 hatcheries and refuges. These policies and mandates include the following: intentional barriers to fish passage to provide water that is free of regulated pathogens for hatchery purposes; and, maintenance of freshwater wetlands for migratory bird habitat which can prohibit fish passage. In locations where it is decided that fish passage should be provided, additional data would be necessary in order to design an appropriate fix; and then finally remove the barrier or replace it with a fish passable structure.

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